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UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Entomology
Office of Forest Insect Investigations

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Dr. A. D. Hopkins
In Charge of Forest Insect Investigations

Dear Sir:

Pursuant to the outline of investigations for the Northwestern Station in 1905, I am submitting herewith a summary of results.

A. Investigations of damage to northwestern forests by the hemlock span worm, and other defoliating insects, to determine:

a. The species which defoliates hemlock, spruce, and other forest trees on large areas in the northwestern coast and mountain region.

Nothing new determined, no defoliation being found.

b. Life history and natural enemies of hemlock and spruce geometrids, in cooperation with Dr. Dyar.

Nothing new determined, no species being found.

c. Further facts relating to extent of damage from present and former invasions. Location and distribution of sections in which destructive work has been noted.

Nothing new determined.

d. Causes of rapid multiplication and sudden disappearances.

Nothing was determined.

B. Investigation of damage to living hemlock timber by the hemlock bark-maggot.

Desirable facts determined in 1904. Additional facts determined:

1. The insect (Cheilosia alaskensis) lives over one whole year in the larval stage.
2. The larva enters wounds made by sapsuckers.
3. It enters these wounds in the slight flow of pitch which exudes while they are healing.
4. It enters old healing Cheilosia wounds in the same manner.
5. When pupating, it does not necessarily curl its tail over its back and twist up.
6. The insects infests the western hemlock at the highest altitudes in which that tree grows on Mt. Rainier, Washington.

C. Investigation of damage to reproduction spruce, fir, and other conifers by bark weevils, to determine:

a. Character and extent of damage, (1) to terminal shoots;

The western spruce weevil (Pissodes sitchensis n.sp.) kills the previous year's growth of the terminals of many reproduction Sitka spruce (Picea sitchensis) in Washington State. In small clumps of trees, five out of six, three out of five, and ten out of thirty-two, have been found with dead terminals. Some had had their terminals killed several times in the course of a few years. Young trees 2 - 8 inches in diameter land from five to twenty-five feet in height appear to be the only ones attacked. As a single lateral usually takes the place of the destroyed terminal, no permanent damage is inflicted on the injured tree.

Pissodes engelmanni, n.sp., closely related to the western spruce weevil, kills the terminals of the Engelmann spruce (Picea engelmanni) in Washington, Oregon, and Idaho. It is quite common, and besides killing the previous year's growth of the terminal, will work downward killing 2 and 3 year and even older growth, thus permanently injuring the tree by causing a deformed top and a stunted growth.

Neither of these species were found attacking any part of their host except the terminal.

(2) to the stem and base;

Broods of Pissodes fasciatus Lec. were quite common in the bark at the bases of dying Douglas spruce saplings near Pialschie, Washington. In nearly every case the brood was found in the bark just above the surface of the grounds. Associated with the Pissodes attack was a white fungus which nearly always separated the bark from the roots just below the ground. In one case, however, the Pissodes attack extended from the butt to the top

of a large sapling and there was no fungus attack. This indicates that the tree was killed by the Pissodes. The foliage was brown and falling, but the bark was still alive in spots. Scolytus unispinosus was usually associated with the Pissodes attack. It attacks when the tree is dying, and breeds in the bark on the upper part of the trunk.

Pissodes piperi, n.sp., work and fragments of dead adults were found in and under the bark of small dead alpine fir saplings, near the timber line on Mt. Rainier, Washington. A brood of large larvae was found in the dying bark on the butt of a small blown over tree. This species probably kills saplings injured by the snow or wind. Quite a number of dead saplings were found that had the Pissodes work in the bark and on the wood.

Pissodes radiatus, n. sp., aids Dendroctonus valens and Tomicus plastographus to kill Monterey pine at Palo Alto, California. It attacks the bark of the main trunk and rears its brood there.

Pissodes costatus mann, n.sp., attacks the dying bark of stumps and the main trunk of girdled Sitka spruces in western Washington.

b. Life histories, habits, natural enemies, etc.

The life history of Pissodes sitchensis is quite complex, for the broods overlap a great deal. The adults emerge from the first of June until the first of December. Part of a brood may emerge in October and November, and the remaining part in May or June. The eggs found by the writer were laid in June, in little cavities in the last year's bark of a lateral that was growing up to take the place of a terminal that had been killed the year before. Two eggs were deposited in each of the cavities which were excavated irregularly up and down the stem for three or four inches from the tip down. Large larvae and pupae were found in the dead terminal and a brood of small larvae were working in the living bark at its base. Three broods were in the same top at the same time; one fully developed and ready to emerge from the dead terminal; a brood of small larvae at the base of the dead terminal, and the eggs in the top of the leading lateral. This was the only case found where a top was infested by more than one brood. A typical life history would be; eggs laid in June in the bark of the last year's growth of the terminal from the tip down for from 3 to 6 inches or more; larvae soon hatching out and working downward in the bark, completely girdling the stem and finally causing the death of the portion above; the stronger ones, probably those earliest hatched, working on ahead, reaching full development and pupating in a shredded covered cell in the wood or rarely, where the wood is thin, in the pith; changing to adults and emerging in August, September, October, and November; some weaker ones following on behind, pupating in October or November, wintering over as pupae and changing to adults and emerging in May or June; and the weakest ones straggling along, wintering as larvae, pupating in May or June, and transforming and emerging in June or July.

The young adults feed on the fresh bark of the young trees and may cause some damage by their food punctures. In cages in the laboratory, and on growing trees in the field, they fed on the bark of the trunk about as readily as they did on the bark of the terminals or twigs. No eggs were deposited, however, and the insect probably passes one winter in the adult stage before mating and ovipositing.

The young larvae are often so numerous under the bark of an infested terminal that they form a complete girdle or common mine in which they live together. Later some are crowded out and starved, and each survivor has a separate mine. Usually, though, they are so close together that the inner bark is practically all eaten away.

Although the terminal is practically dead, the new growth keeps on and does not finally wilt and turn brown until the late summer or fall, when it has reached almost normal growth for the season.

Pissodes sitchensis has several formidable natural enemies. The larvae of Lonchae polita Say are nearly always present in numbers in the larval mines and pupal cells. They feed on the dead and dying larvae and pupae, and there is strong evidence that they will kill perfectly normal larvae and pupae. They pupate in May and June and the adults emerge during the same months. The larvae of a Lepidopteran, Diorcyctria abietella, was found several times during August and September in Pissodes larval mines. It may be a predaceous enemy. Braconid parasites of the genera Coeloides, Brachychistes and Macrodyctium were reared from cocoons found in Pissodes pupal cells. Three species of Chalcid flies and one Cynipid were reared from the Pissodes infested terminals. Several broods showed every evidence of having been destroyed by some bacterial or other disease.

Pissodes engelmanni attacks and kills the terminal shoots of the Engelmann spruce in much the same manner that Pissodes sitchensis kills the terminal shoots of the Sitka spruce. It attacks larger and older trees, however, and where the spruce is not very common as at Smith's Ferry, Idaho, where the study of the insect was made, it attacks the same tree more often, year after year, and thus keeps it short and stunted, with the top bushily deformed. It will also kill two and three year old growth of the terminal, which Pissodes sitchensis was not observed to do. In October, 1904, large larvae, pupae, and young adults were found in the pupal cells in the sapwood. Some adults had emerged. It thus seems probable that the life history is nearly the same as that of Pissodes sitchensis. Lonchea larva were quite common under the bark of the infested

terminals and in the Pissodes pupal cells. Chalcid larvae and Ichneumon cocoons were also often found in the pupal cells. The adults of these Hymenopterous parasites were reared, but have not been determined yet.

Pissodes fasciatus Lec. adults were found ovipositing in the healing bark at the upper edge of girdles on large Douglas spruce trees at Hoquiam, Washington, May 16th. Large larvae were found in the bark on September 15th. From a pupa found in the bark of a limb on August 1st, an adult emerged August 7th. At Pialschie, Washington, large active larvae and large larvae and pupae in pupal cells were found in the bark at the base of a small Douglas spruce tree in June. In July, pupae and young adults were found; in August large active larvae, large larvae, pupae, and young adults in pupal cells and fresh exit holes; in September large larvae and young adults in the pupal cells; and in October active larvae. It appears from these notes that there is one brood a year: the eggs are laid in May or June, the larvae feed in the bark until the following May or June, then pupate, changing to adults and emerging in July, August, and September. The adults live over the winter, mate and oviposit the second spring; the life cycle from egg to egg being two years.

Several specimens of an undetermined Chalcid parasite were reared during September from larvae obtained from the Pissodes pupal cells in August. There are now in the breeding vials a number of Ichneumon larvae and cocoons obtained from the pupal cells at the same time.

Pissodes piperi large larvae were found working in the dying bark of a small fallen tree August 23, 1905, the adults of the year had emerged. From all indications, it appears that at the high altitude of Paradise Valley, the eggs are laid in June or July, the larvae live over the winter in the bark and pupate, transform to adults, and emerge the following June. The adults live over the second winter, mate and oviposit the second spring or summer.

Pissodes radiatus large larvae, pupae and young adults were found in the pupal cells May 3d. Some adults had already emerged. This species follows Pissodes fasciatus quite closely, and probably has the same life history, being a little earlier in California because of the climatic conditions. No parasites were observed.

Pissodes Costatus Mann also seems to be single brooded. One adult was taken flying around a stump in May and one adult emerged in the laboratory in July. Larvae were found in the bark in April, May, July, August, and September, and in pupal cells in the surface of the wood during May, June, August, and September. Pupae were found in the pupal cells in May and June. Of three trees girdled June 11, 1903, large larvae were found under the bark of one on April 29, 1904, large larvae and pupae in the pupal cells of another June 21, 1904, and the fragments of an

adult in a pupal cell of the third on September 19, 1904. On July 22, 1904, medium sized larvae were found in the bark of a tree felled May 27, 1904. These facts tend to show that the eggs are laid in June and July, the larvae live over the winter, pupate in April, May, June, or July, and transform to adults and emerge some time during June, July, or August. The adults live over the following winter before mating and ovipositing. An Ichneumonid cocoon was found in a Pissodes pupal cell on June 21, 1904. Unfortunately, the adult was not reared.

C. Whether or not the species breeds in the bark of stumps and trunks of dying and felled trees, and if so, the size of trees preferred and conditions as to time of felling, etc., favorable for such attack.

Pissodes sitchensis and engelmanni were not found breeding in the bark of stumps and trunks of dying and felled trees. P. fasciatus, piperi, radiatus, and burkei were found there. Sitchensis and engelmanni seem never to breed in any place except the living terminals of saplings. Fasciatus and piperi will breed in living saplings or the stumps and trunks of large trees. Fasciatus also sometimes breeds in dying limbs. Radiatus undoubtedly aids Dendroctonus valens and Tomicus plastographus to kill large trees, while burkei costatus mann seems to breed only in the stumps and trunks of dying and felled trees. Fasciatus oviposited in May, '05, in trees girdled in May and August, '04, while burkei soon attacked the stumps of trees girdled and felled in May and June. Both have been found in stumps several years old. Stumps of cut or girdled in the spring or summer seem to offer the most attractive breeding places, but they will attack any dying bark that is greenish and not dry.

s/H. E. BURKE
Special Field Agent